

*Symbiotic stars probing stellar evolution*  
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## A search for Symbiotic Stars in the Local Group

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**Abstract.** The Local Group Census is a narrow- and broad-band survey of all the galaxies of the Local Group above  $\delta = -30^\circ$ , in progress at the 2.5m Isaac Newton telescope on La Palma. We discuss here the ability of the survey to detect symbiotic star candidates in the Local Group, by deriving detection limits in each of the narrow- and broad-band frames used in the survey, and by estimating the total number of objects expected in each galaxy. We present two diagnostic diagrams, based on the adopted photometric filters, to discriminate between symbiotic stars and other emission-line objects such as planetary nebulae.

### 1. Introduction

The Local Group Census (LGC) is a narrow- and broad-band survey of all the galaxies of the Local Group (LG) above  $\delta = -30^\circ$  (<http://www.ing.iac.es/WFS/LGC/>). It is carried out as part of the Isaac Newton Group's Wide Field Survey program and its observations are being obtained with the Wide Field Camera at the 2.5m Isaac Newton telescope, equipped with a 4-CCD mosaic covering a field of view of  $34' \times 34'$ .

The LG galaxies have been observed through narrow-band filters ( $[\text{O III}] \lambda 5007\text{\AA}$ ,  $\text{H}\alpha$ ,  $\text{He II } \lambda 4686\text{\AA}$ , and  $[\text{S II}] \lambda 6725\text{\AA}$ ) and broad band filters (Sloan  $g'$ ,  $r'$ ,  $i'$ , and Strömgren  $y$ ). One of the goals of the LGC is the search for symbiotic star candidates in galactic systems other than the Milky Way, using the broad-band color index  $g'-i'$  to detect the red giants and the narrow-band  $\text{H}\alpha$  filter to select those with a strong emission from circumbinary gas.

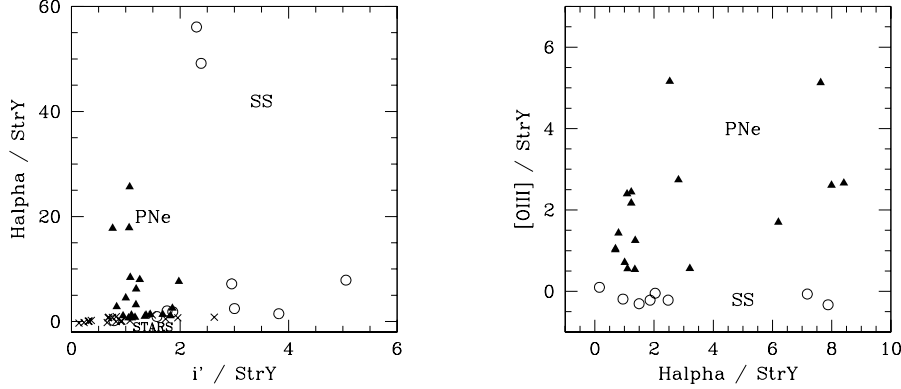


Figure 1. Diagnostic diagrams useful in the search for extra-galactic symbiotic stars. Triangles are PNe in M33 discovered by Magrini et al. (2000, 2001), empty circles are symbiotic stars from Munari & Zwitter (2002) spectrophotometric atlas, and crosses are normal field stars.

## 2. Diagnostic diagrams to identify symbiotic stars

The images taken for the Local Group Census are quite deep and complete including observations of most of the northern LG galaxies. Our aim is to find simple diagnostic diagrams allowing to detect symbiotic star candidates using only the information provided by our survey. The nebulae around symbiotic systems are often similar to PNe in terms of excitation conditions and chemical abundances, in particular those around symbiotic Miras. The spectrum of some of the latter in the region 4000 to 7000 Å is in fact quite indistinguishable from that of planetary nebulae.

Using data from the recent multi-epoch spectrophotometric atlas of symbiotic stars by Munari & Zwitter (2002), we have built and evaluated two diagnostic diagrams which should be useful in distinguishing between symbiotic stars and PNe on the base of the photometric filters used in our survey. The presence of a cool giant is easily revealed by comparing  $i'$  and Strömgren  $y$ , the circumstellar material stands up well by comparing  $H\alpha$  and Strömgren  $y$  and the high electronic density conditions characterizing symbiotic stars affects the relation between  $[O\ III]$  and Strömgren  $y$ .

## 3. How far can a symbiotic star be detected in our Survey?

To estimate the sensitivity in distance of our survey, we have picked out several prototype symbiotic stars from the atlas of Munari & Zwitter (2002), namely: carbon symbiotic stars, symbiotic novae in outburst, classical symbiotic stars in outburst, quiescent yellow and normal symbiotics, symbiotic Miras. With filter band profiles taken from Moro & Munari (2000), we have derived via synthetic photometry the flux in each filter and corrected for the symbiotic star distance estimated via infrared spectrophotometric parallax of the cool giant. We did not

Name	Type	M ( $M_{\odot}$ )	N.Symbiotic Stars ( $K - B$ )
Milky Way	Sb I-II	$1.8-3.7 \times 10^{11}$	400,000
WLM	IrrIV-V	$1.5 \times 10^8$	0
IC 10	IrrIV	$6. \times 10^8$	150
NGC 147	Sph	$5.5 \times 10^7$	2,800
NGC 185	Sph	$6.6 \times 10^8$	4,200
NGC 205	Sph	$7.5 \times 10^8$	17,000
M 32	E2	$1.1 \times 10^9$	19,000
M 31	SbI-II	$2-4 \times 10^{11}$	660,000
LGS 3	dIrr/dSph	$2.6 \times 10^7$	-
IC 1613	IrrV	$1. \times 10^8$	0
M 33	ScII-III	$0.8-1.4 \times 10^{10}$	45,000
Fornax	dSph	$6.8 \times 10^7$	500
EGB0427+63	Ir		-
Leo A	Ir V	$<9. \times 10^7$	0
Sextans B	IrIV-V	$8.8 \times 10^8$	0
NGC 3109	IrIV	$2.3 \times 10^9$	0
Leo I	dSph	$>2. \times 10^7$	200
Sextans A	IrV	$>1.9 \times 10^8$	0
Leo II	dSph	$1.1 \times 10^7$	50
GR 8	dIrr		0
Ursa Minor	dSph	$1.7 \times 10^7$	0
Draco	dSph	$1.7 \times 10^7$	10
Sagittarius	dSph	$1.5 \times 10^8$	-
NGC 6822	IrrIV-V	$1.7 \times 10^9$	0
DDO 210	dIrr	$1.4 \times 10^7$	0
Pegasus	IrV	$2.7 \times 10^7$	0

Table 1. Galaxies in the LGC program and the expected number of symbiotic systems computed from  $K$  and  $B$  data (see sec.4 for details). Only a small part of them could be in an active state (bright emission lines) and therefore been detectable by our survey.

correct for reddening to account for typical reddening conditions encountered in the LG. The scaled fluxes ( $H\alpha$ , [O III], Strömgren  $y$  and  $i'$ ) of the stars in the sample span a relatively narrow range, and this allows to consider the median value of the fluxes in each filter in computing the greatest distance to detect a typical symbiotic star with the LGC survey.

Using the WFC at the prime focus of the Isaac Newton telescope (2.5m) and the exposure times set by the LGC (3600 s through the  $H\alpha$  and [O III] filters, 1800 s through the Strömgren  $y$  filter and 1200 s through the  $i'$  filter), a typical symbiotic star can be observed with a signal to noise of 5 at the distance of approximately 0.5 Mpc through the  $H\alpha$  filter, of 0.2 Mpc through the [O III] filter, 0.1 Mpc through the Strömgren  $y$  filter and 0.6 Mpc through the  $i'$ . The brightest symbiotic star of our sample can be observed at the distance of 1.6 Mpc ( $H\alpha$ ), of 1.4 Mpc ([O III]), of 0.8 Mpc (Strömgren  $y$ ) and of 1.6 Mpc ( $i'$ ). These limits suggest that in the closer LG galaxies we can detect symbiotic stars over a large range of intrinsic luminosity, while for the farthest LG sample only the brightest objects will be reveal with a useful S/N ratio.

#### 4. How many symbiotic stars could be detected in each LC galaxy?

Few symbiotic stars are known in external galaxies: 8 in the LMC, 6 in the SMC and 1 in Draco (Belczyński et al. 2000). No one of these surveys is complete and so they cannot give information about the number of the expected symbiotic stars in each LG galaxy. A total number of  $3 \times 10^5$  symbiotic star is estimated in our Galaxy by Munari & Renzini (1992),  $3 \times 10^4$  by Kenyon et al. (1992) and  $3 \times 10^3$  by Allen (1984). So far only  $\sim 200$  have been discovered.

We considered a qualitative way to estimate the approximate expected number of symbiotic stars in each galaxy. From the  $K$  and  $B$  magnitudes (LEDA Lyon-Meudon Extragalactic Database, <http://leda.univ-lyon1.fr/> and Fioc & Rocca-Volmerange 1999), the distances (van den Bergh 2000), the contribution in near infrared light of young stars (Chiosi & Vallenari 1996), a rough estimate of the red giant population in each galaxy can be computed. A typical luminosity of  $100 L_{\odot}$  for a cool giant is taken in computing the number of red giants per galaxy. The number of symbiotic stars can be taken to be 0.5% of the total number of red giants. Only a fraction of them can be observed in the “active” phase, i.e. with a typical spectrum containing bright emission line. From Table 1 it can be noted that the number of expected symbiotic stars is quite dependent on the mass of the galaxy. For several irregular galaxies the number of symbiotic stars estimated in this way is not reliable due the greater amount of  $B$  light respect to  $K$  light.

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